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Goalkeeper: A Zero-Sum Exergame for Motivating Physical Activity

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Abstract. Incentives and peer competition have so far been employed independently for increasing physical activity. In this paper, we introduce Goalkeeper, a mobile application that utilizes deposit contracts for motivating physical activity in group settings. Goalkeeper enables one to set up a physical exercise challenge with a group of peers that deposit a fixed amount of money for participating. If a peer fails to complete the challenge, Goalkeeper redistributes their deposit to those who managed to complete it (i.e., zero-sum game). We evaluated the potential of Goalkeeper in increasing physical activity with a total of 50 participants over the course of 2 months. Our findings suggest that deposit contracts induce a loss-aversion bias, that in combination with peer competition, is effective in increasing exercise motivation. Ultimately, we generate a set of design principles for exergames that utilize deposit contracts for increasing physical activity in group settings.

Keywords: Physical activity · Motivation · Exercise contracts · Peer competition · Zero-sum game

1 Introduction

Modern sedentary lifestyle has been identified as one of the leading causes of preventable death worldwide. Prolonged physical inactivity has been linked to cardiovascular diseases, type 2 diabetes, depression, and even some types of cancer [62]. In fact, cardiovascular diseases were the leading cause of death in the United States, accounting for more than 900,000 deaths in 2016 with a considerable number linked to low levels of physical activity [52]. Traditionally, adopting a healthier lifestyle by promoting physical exercise has been deemed the remedy for the aforementioned health risks [68]. This has sparked a great interest in creating and developing a plethora of wearable devices, mobile applications, and websites that

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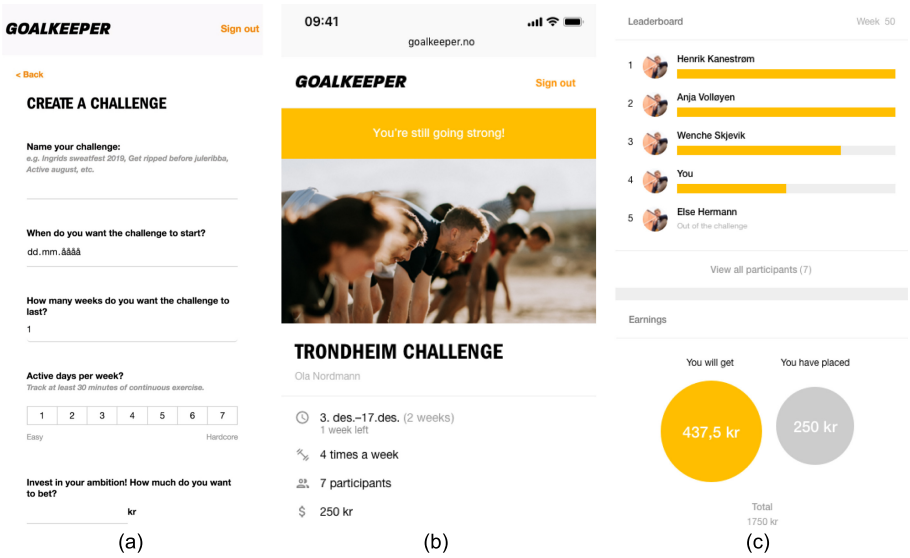

Fig. 1. The User Interface of the Goalkeeper mobile app with the main functionalities of: (a) setting up a challenge, (b) keeping track of a challenge, and (c) viewing leaderboard and amount invested in the current challenge.

can track one's physical activity and motivate one to exercise more. As a result, the sales of fitness-tracking enabled devices (e.g., Fitbit, Garmin Fitness, Apple Watch, etc.) has skyrocketed. However, medical studies have shown that the long-term health benefits of fitness trackers are rather limited [10,25]. In fact, mobile health researchers, practitioners, and system developers still struggle to identify strategies for retaining users well after the fitness trackers' novelty has worn off [41]. Prominent HCI research has identified the lack of goal setting as the primary culprit for discontinued use of fitness trackers [18,47]. Here, we posit that peer pressure and loss aversion can be combined for increasing the motivation to exercise.

Peer pressure through social networking has been considered an affordable alternative to increasing physical exercise motivation [43]. While social networks were still in their infancy, Toscos et al., proposed the use of a "cell phone" application for motivating teenage girls to exercise by leveraging on their desire to stay connected with their peers [61]. Nowadays, the idea of using social networking to promote physical exercise is well-received. Skriloff et al., developed an asynchronous-play social game platform that they claim fills the gap in motivation left by fitness trackers [55]. Gui et al., aimed at the same gap by developing WeRun, a plugin for a social networking service for sharing fitness data among peers [19]. WeRun was found to sustain participants' interest in fitness tracking and exercise motivation. Kaos et al., investigated the social play dimension of exergaming in 6-week trials [27]. They found that people who engage in group play have superior adherence to people who primarily play alone. Generally, "social validation" is considered the main driver for human behaviour [15]. Thus, approaches that utilize peer pressure are particularly effective in increasing exercise motivation.

"**Loss aversion**," introduced by Tversky and Kahneman [26], is a prominent theory in the field of Behavioral Economics that can also be pivotal in increasing exercise motivation. The loss aversion theory describes the strong reluctance to give away a bestowed utility. A direct implication of loss aversion is that the loss of utility linked to a valued good is greater than the utility gain linked with receiving it [63]. The simplest explanation of the loss aversion theory is the two following scenarios of a coin toss: In (a) heads will make you lose 100€ and tails will make you win 200€. Conversely in (b), heads will make you lose 200€ and tails will make you win 100€. Scenario (a) appears attractive, since the potential gains outweigh possible losses. However, in scenario (b), loss aversion manifests, resulting in a person to less likely flip the coin. Innately, humans are more aversive to losses than attracted to gains–"*losses loom larger than gains* [63]."

In practice, Goalkeeper implements the loss aversion theory by the formation of deposit contracts that require one to deposit a specific amount of money to participate in a physical exercise challenge. On one hand, we expect that the requirement for investing a deposit from one's own funds—forming a deposit contract—will greatly strengthen commitment to a physical exercise challenge (i.e., adherence). On the other hand, this commitment can only be further bolstered by peer competition, and the possibility of one benefiting from a peer's failure to complete a challenge. In essence, Goalkeeper is a zero-sum game: In the field of game theory, zero-sum game is a situation in which each participant's gain or loss of utility is exactly balanced by the losses or gains of the utility of the other participants [9]. Thus, Goalkeeper displays a significant potential for motivating physical activity, without utilizing additional hardware apart from a typical smartphone. In this paper, we present findings from testing Goalkeeper with 50 participants in a study with a total duration of 2 months. Based on our findings, we elicit a set of design principles for exergames that utilized deposit contracts for increasing physical activity in group settings.

2 Related Work

A systematic literature review by Texeira et al., elucidated the factors that inhibit motivation in physical activity by examining a total of 66 relevant studies published until 2011 [59]. Drawing on the self-determination theory, the authors differentiate between intrinsic and extrinsic types of physical exercise motivation. As such, when one is intrinsically motivated, they experience enjoyment, personal accomplishment, and excitement [31]. Conversely, when one is extrinsically motivated, they are typically outcome-driven, by aiming for a tangible or social reward, or by avoiding disapproval (i.e., social validation by peer pressure). The literature review by Teixeira et al., highlights the role of developing self-regulation via autonomous forms of extrinsic or intrinsic motivation [59]. In fact, high autonomous motivation is linked with sustaining exercise behaviors over time (i.e., high adherence). Typically, exergames employ a form of gamification (e.g., achievements, leaderboards, points, etc.) following design guidelines for the representation of physical activity data with the aim to boost intrinsic and extrinsic motivation [29].

Prior studies in literature propose the idea of turning exercise into an indoor game with the use of Virtual Reality (VR) or Augmented Reality (AR) headsets, Microsoft Kinect, or other devices, thus coining the term "exergames [42]." For example, Ganesan and Anthony came up with an early prototype game that used Microsoft Kinect for tracking the movement of elderly people in order to help them be more active [17]. Bolt et al., designed a VR cycling based game that utilizes the Oculus Rift VR headset, a stationary bicycle and Microsoft Kinect to detect when a user performs the move of throwing a newspaper into neighbourhood mailboxes [8]. Hagen et al., designed an online multiplayer exergame where one controls a tank by pedaling on a stationary bicycle [20]. Players compete with each other in a "capture the flag" arena game. In the same guise, Ijaz et al. designed VR-Rides, an exergame platform that uses and the HTC VIVE VR headset and a stationary bicycle for enabling one to navigate in a safe virtual environment comprised of Google Street View imagery [24]. ExerCube utilizes a cube immersive environment that tracks and surrounds a player with 3 video-walls [40]. The walls serve both as projection screens and a haptic interface for energetic bodily interactions with the aim to enhance personal training. Fitnamo is another exergame that utilizes Google Glass for providing entertaining exercise routines and encouraging a user to be active [46]. Undoubtedly, exergames is an effective way to motivate physical activity. However, with the exception of Pokémon GO[1] and the like, exergames often require expensive equipment that is also likely to be cumbersome to wear or use, while they are mostly played indoors. Moreover, the habit-forming nature of exergames is under-explored. In other words, there is a lack of evidence that exergames can instil an exercise habit that can be sustained in the long-term [28]. Thus, there is a need for new types of applications that will stimulate users' motivation to exercise, while keeping some of the game design aspects which make the experience more fun or engaging in the long-run.

2.1 Gamifying Physical Activity: The Case of Pokémon GO

When it was first launched in 2016, Pokémon GO was deemed by many the pinnacle of exergaming [34,49,66]. Pokémon Go is an AR mobile game developed and published by Niantic in collaboration with The Pokémon Company for iOS and Android devices. It uses the mobile device GPS to locate, capture, combat, and train virtual creatures (Pokémons), called Pokémon, which appear embedded in the player's real world. Pokémon GO utilizes a combined effect of intrinsic and extrinsic motivation, attributed to collecting Pokémons and combating other users, respectively. Indeed, Pokémon GO has been found to increase walking activity of previously idle users [34], it promotes cross-generational play [49], and it may help engage young adults suffering from severe social withdrawal [58]. Conversely, Pokémon GO has led to accidents during playing and driving or cycling, walking without paying attention, and has been linked to trespassing [66]. Most importantly however, a recent systematic literature review showed

[1] https://pokemongolive.com/en/.

that despite the fact that Pokémon GO yields a statistically significant increase in the number of daily steps, the increase is clinically modest [28]. Plus, longer follow-up study periods are required for reliably assessing if Pokémon GO can promote physical activity over longer periods [28]. In other words, the health benefits associated with playing Pokémon GO were moderate and questionable in the long-run.

2.2 Deposit Contracts and Physical Activity Motivation

Some exergames may introduce storytelling to engage users in physical activity (e.g., Zombies, Run![2] and Step Ahead[3]), whereas others focus on goal-setting (e.g., Runkeeper[4]) and financial incentives (e.g., StepCity [67]). A special category of financial exergames are those that employ deposit contracts. To boost one's self-discipline, one may commit to goals by voluntarily accepting deadlines with consequences [57]. Deposit contracts are pre-commitment strategies that force one's future self to certain behaviors [60]. In the field of Behavioral Economics, deposit contracts have been extensively utilized for helping one achieve self-defined goals in a certain period [16,36]. Deposit contracts utilize monetary incentives funded by one's own money, invested in completing a (personal) goal. In case one fails to achieve the goal, one loses the deposited amount.

So far, numerous studies have investigated how financial incentives can motivate people to reduce alcohol consumption [45,70], reduce tobacco use [23], improve their nutrition [39], and increase their physical activity levels [51]. However, this work focuses on how deposit contracts (and peer competition) increase physical activity. A study by Burns and Rothman compares different types of financial incentives in how they affect walking behavior [12]. The study had a sample size of 153 participants, randomly assigned in four groups with different incentive conditions. Participants in the deposit contract group were told that they had a bank account with $50 deposited, and that over the next five weeks they would lose money from their bank account each week if the goal was not met. Interestingly, the observed effect on walking did not differ across different incentive conditions. Deposit contracts were not more effective than cash rewards in increasing the frequency or likelihood of meeting a walking goal. However, exploratory analyses indicated that the perceived value of the incentive was associated with walking behavior over time. Lesser et al., examined how deposit contracts could help one to lose weight by utilizing a website that employs deposit contracts as a motivation factor [36]. The participants made individual deposit contracts and they were free to deposit as much money as they wished. The amount of deposit, period, and the weekly weight-loss goal could be decided by themselves. After setting the goal, the participants could select from four types of contract that would be activated if they failed: anti-charity—money goes to a charity/organization opposite to what the individual

[2] https://zombiesrungame.com/.
[3] https://www.astepaheadchallenge.com/.
[4] https://runkeeper.com/cms/.

supports, charity—money goes to a general charity fund, friend—money goes to participants' designated "friend," and no deposit—no money invested at all. The outcome of this study was that the type of contract and size had a moderate effect on keeping up with a goal, but individuals that used deposit contracts appear to lose weight. Notably, Behavioral Economics suggest that anti-charity is the most effective motivator, with "no deposit" as the least effective. The conclusion was that voluntary use of commitment contracts may assist weight loss [36].

Deposit contracts have been utilized by several commercial applications and services (e.g., sticKK.com, SPAR!, and waybetter.com). Despite the fact that deposit contracts is a well-received strategy for motivating behavioral change, both scientifically and commercially, there is a lack of studies that inquire into the effect of deposit contracts in closed social groups. As we have seen, some studies bring evidence forward about the effect the deposit amount bears on motivation. However, there is little research on how people experience pursuing a goal or if their behavior changes during this challenge. In this work, we look into how deposit contracts can be utilized as an effective goal-setting strategy using a mobile application called Goalkeeper (see Fig. 1). Goalkeeper has similar rules as Waybetter's applications, but instead of the term "games" it uses the term "challenges", while it only focuses on motivating physical activity within user-made, closed social groups. Notably, social groups in this study are groups of people that are friends or acquaintances—we refer to both types of relationships as "peers."

2.3 Is Goalkeeper Betting?

Goalkeeper's challenges are neither defined nor described as betting, gambling, or lottery, even though they involve depositing, earning, or losing money. On one hand, according to the Oxford Dictionary of English [56], the definition of the term "*betting*" is "*The action of gambling money on the outcome of a race, game, or other unpredictable event.*" Also, the definition for the term "*lottery*" is "*A means of raising money by selling numbered tickets and giving prizes to the holders of numbers drawn at random.*" On the other hand, the definition of "*deposit contract*" is "*an agreement between a financial institution and its customer*," according to US Law[5]. The Norwegian Gaming Authority[6] declared that **Goalkeeper is neither a betting nor a lottery game, since every participant has a chance to get their money back**. Goalkeeper's challenges have no unpredictable outcomes, except for the cases of sickness or death. Nevertheless, in this study we will not take sickness or death into account, but we will not call Goalkeeper a betting or a lottery game, since the Norwegian law does not define the concept as such. However, the questionnaires, used in this study, include question items about betting to investigate if the participants have joined a commitment with money before, and the term "bet" is used in the system as

[5] https://definitions.uslegal.com/d/deposit-contract/.
[6] https://lottstift.no/en/the-gaming-and-foundation-authority/.

"Place your bets" when supplying the deposit money (see Fig. 1). Furthermore, a feature is under development that can refund people due to sickness, and it will be available in a future version of Goalkeeper. In conclusion, we will use the terms "investing" and "*deposit contract*" when referring to Goalkeeper.

3 The Goalkeeper App

The Goalkeeper's functionality is essentially implemented on 3 Application Programming Interfaces (APIs), namely Facebook API, Vipps API, and Strava API. Goalkeeper utilizes Facebook API login and befriend functionalities for authentication and presenting a peer with an exercise challenge. Vipps API is then used for safely collecting (and returning) the deposits from all the peers who accepted the exercise challenge, in the form of mobile payments. The Strava API is tasked with monitoring the physical activity of each peer participating in the exercise challenge for the entire duration of the challenge. From a mobile user's perspective, the Goalkeeper supports the following primary actions: (1) create a challenge by setting a start and an end date—a challenge should last at least for a week, (2) decide how many exercise days (sessions) the participants should complete during each week, (3) set the amount of the deposit each participant should pay for joining in, (4) invite peers to join the challenge before the challenge can start. Typically, 150 min of moderate exercise intensity per week is recommended for adults of 18–64 years old. However, for motivating people to start exercising, we "lowered the bar" to an exercise duration of at least 30 minutes for a session to count towards completing a challenge. In its current version, Goalkeeper approves any variant of physical activity, such as walking, running, yoga, and others, as long as they last for more than 30 minutes per session. Upon the end of an exercise challenge, Goalkeeper returns the deposited amount back to each participant who successfully completed the challenge. In the event a participant fails to complete the exercise challenge, their deposit is distributed evenly among the other participants who completed the challenge. In the unlikely event all participants fail to complete the exercise challenge, Goalkeeper returns to everyone their deposits (i.e., zero-sum game [9]).

4 Study

Drawing on the loss aversion theory [63], and prior literature on physical exercise motivation and exergames, we hypothesize that the requirement for a monetary incentive, invested by the participants themselves (i.e., deposit contract), will result in motivating them to complete an exercise challenge. In turn, we anticipate an increase in the overall physical activity levels of our participants. Bearing in mind the limitations of previous studies, we seek to answer the following research questions (RQs):

RQ1: **Are deposit contracts an effective strategy for motivating physical activity on a mobile application?** Prior studies have investigated the introduction of financial incentives for reducing alcohol consumption [45], marijuana [70], and tobacco use [23], improving nutrition [39], and increasing physical activity [12,51]. However, our work differs in that it proposes the idea of utilizing one's own funds as a financial incentive for one to exercise. In fact, one is further convinced to invest in an exercise challenge by the possibility of profiting in case one's peers fail to complete the same challenge. Thus, we expect that the potential of profiting, with the inherent risk of losing one's own money, will motivate our participants to commit to an exercise challenge, and increase their physical activity levels. However, we do expect a higher success rate in the 2-week challenge as opposed to the 6-week one, simply due to the increased period of commitment required in the 6-week challenge.

RQ2: **How do group dynamics motivate physical activity when deposit contracts are involved?** Peer competition is a well-known way for increasing physical activity [69]. For example, online social networks have been found to increase social activity [71], and promote weight loss [33]. However, the interplay between group dynamics and deposit contracts remains under-explored, particularly in user-made, closed group settings. Besides striving for reclaiming one's invested deposit, we expect that participating in an exercise challenge with a group of peers will greatly bolster competition leading to an overall increase in physical activity for all the members of the group.

RQ3: **How does user profile characteristics influence how participants exercised with Goalkeeper?** Apart from the bodily benefits, physical exercise is highly beneficial for one's emotional state, inducing positive emotions [7], and reducing negative emotions such as stress [54]. In fact, post-exercise positive emotions play a central role in continuing exercising [21]. Thus, we expect Goalkeeper will be associated with inducing positive emotions, reflected on challenge outcome, and invested deposit amounts. We also expect age, and particularly gender, to have a bearing on challenge outcome and deposit amount, given that males engage in risk-taking behaviors more frequently than females do [14].

4.1 Participants and Groups

We recruited a total of 50 healthy and **adult** participants from the premises of NTNU in Norway. We specifically opted for recruiting participants that know each other, and would form exercise groups based on friendship, or at least acquaintance. Typically, students, as young adults, are technology enthusiasts, and thus more curious to try out a novel mobile application such as Goalkeeper. Two participants (1 male and 1 female) dropped out before the actual exercise challenges commence due to not being able to keep up with a schedule of 3 exercise days per week. **The remaining 48 participants were equally split between the two genders** ($N = 24$ females). All participants were students with the majority falling under the 20–24 years age group ($N = 37$ or 75.5%), followed by the 25–29

age group ($N = 10$ or 20.4%), and the 30–34 age group ($N = 1$ or 2%). Participants selected, within their respective groups, the duration of the exercise challenge in which they would participate by choosing between the 2-week ($N = 21$ or 43.8%) and the 6-week challenge ($N = 27$ or 56.3%). Next, the participants selected, within their respective groups, the amount of money they would deposit in each challenge opting in for 0 ($N = 14$ or 29.2%), 150 ($N = 19$ or 39.6%), or 500 Kr (Krone) ($N = 15$ or 31.3%). In general, **participants were free to organize themselves in groups based on the duration of the challenge, the amount deposited, and personal acquaintance—thus of relatively similar socioeconomic background** [11]. This produced a total of 12 groups whose size ranged from 3 peers ($N = 6$ or 36.7%) to 6 peers ($N = 2$ or 25%). Participants formed all-female groups ($N = 5$ or 41.7%), all-male groups ($N = 4$ or 33.3%), or mixed-gender groups ($N = 3$ or 25%). Upon the completion of the study, each participant was rewarded with a 75 Kr gift card that could be spent in the cafeteria of the University. The reward was intentionally kept significantly smaller than the contract deposits that involved money (150 and 500 Kr).

4.2 Procedure and Measures

Before commencing with the user trials, we had obtained the necessary ethical approval from the National Ethical Board. During the onboarding of our participants, we asked for their informed consent about collecting and analyzing their personal and physical activity data, as well as their questionnaire responses. **We were explicit about the fact that the study does not involve betting, but it requires investing one's money that may be lost**. In particular, we clarified that in the event one fails to complete an exercise challenge, one's deposit is lost and cannot be retrieved. In the current version of the Goalkeeper app, this stands even when one fails to complete an exercise challenge due to illness. All participants belonging to the same group mutually agreed to participate in exercise challenges of predefined duration (2 or 6 weeks) and predefined deposit (0, 150, and 500 Kr), as previously mentioned. For investigating participants' habits, attitude, motivation, and behavior before, during, and after using Goalkeeper app, we employed a series of established measures and methods. One week before the exercise challenges commenced, we administered our first questionnaire comprised of items that target attitude (ATT) [2], exercise motivation (MOT) [44], exercise habits (HAB) [65], and value (VAL) **about participants' relationship with money** [35]. At the start of the 2nd and 3rd week for the 2-week and 6-week challenges, respectively, we administered the second questionnaire. This questionnaire included the previously mentioned MOT and HAB items, as well as continuance intentions for system use (CIU) [6], network exposure (NET) [37], positive (POS) and negative (NEG) emotions [50], exercising with peers (EXE) [53], reciprocal benefits (REB) [22], recognition from peers (REC) [38], subjective norms (SUB) [64], word-of-mouth intentions (WOM) [30], behavioral intention (BEH) and perceived behavioral control (PEB) [65]. We administered the third questionnaire two weeks after a challenge had ended, and it encompassed only factual follow-up question items, such

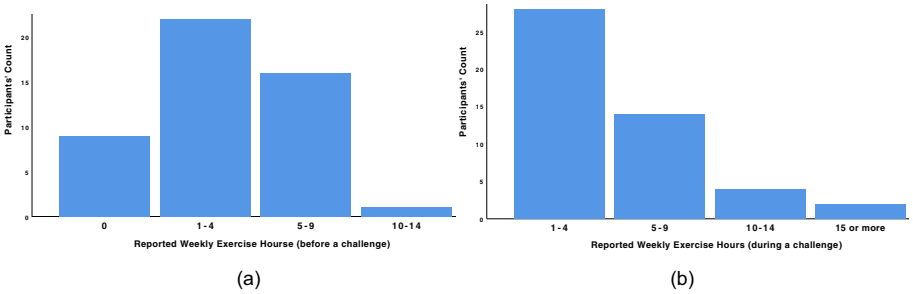

Fig. 2. Reported exercise hours (a) before committing to an exercise challenge with Goalkeeper, and (b) during pursuing an exercise challenge. Participants reported exercising significantly more frequently during an exercise challenge set with Goalkeeper app.

as inquiring whether the participants had exercised or not. All questionnaires were administered electronically, and almost all items were statements to which one could respond by indicating one's level of agreement in a Likert-scale from 1 ("strongly disagree") to 7 ("strongly agree"). We also collected information about participants' demographics, profiles, and challenge outcome (win or loss).

5 Results

For deciding on our statistical methods, we first perform all the necessary pre-tests, such as Shapiro-Wilk tests of normality and Levene's tests of homogeneity of variance. Here, we omit the pre-tests for the sake of brevity. Due to dealing with non-normally distributed data (e.g., dichotomous, categorical, and ordinal variables), we resort to non-parametric tests such as Wilcoxon signed-ranks tests and Pearson chi-square tests of independence. For pinpointing any significant differences after a chi-square test on categorical variables of more than two levels, we perform post-hoc pairwise tests using the adjusted standardized residuals, and an adjusted p value (i.e., Bonferroni method) [3]. Due to lack of space, we mainly opted for presenting results that help us answer our RQs.

5.1 Deposit Contracts and Physical Exercise Motivation (RQ1)

First, we investigated if the introduction of the Goalkeeper app had a positive impact on our participants' exercise frequency when comparing to that of before using the app. From the outset, a Wilcoxon signed-ranks test displayed a significant difference in the reported weekly exercise hours before (Mdn = 1–4 h) and during (Mdn = 5–9 h) a challenge set with Goalkeeper ($Z = -2.558, p < .05$). This indicates that **participants reported exercising significantly more hours per week when pursuing a challenge with Goalkeeper, as opposed to their normal working-out schedule** (RQ1), as shown in Fig. 2. Next, we inquired into whether the deposit amount

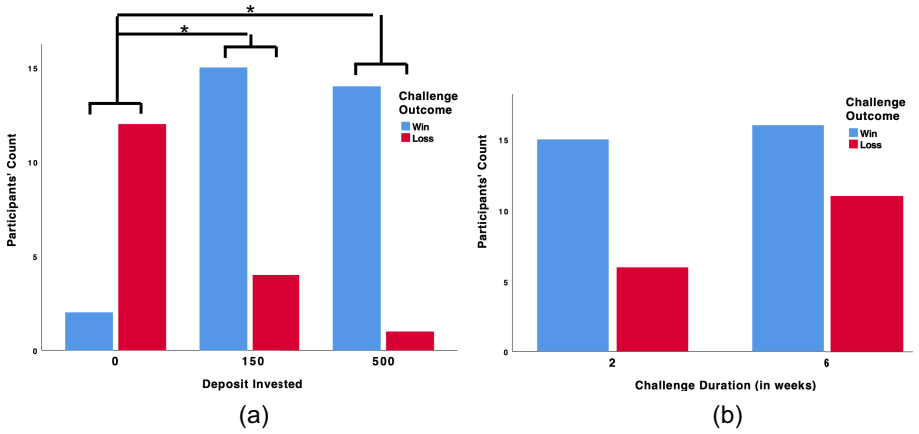

Fig. 3. Number of challenge outcomes in wins and losses in relation to (a) amount of deposit invested, and (b) exercise challenge duration.

invested in a challenge played any role in completing a challenge. A Pearson chi-square test of independence was performed to determine whether there is an association between the amount invested and challenge outcome. The test displayed a significant association between deposit and challenge outcome ($x^2(2) = 22.619, p < .001, V = .686$). A series of pairwise chi-square tests of goodness of fit were performed to determine whether participants completed the challenges in equal numbers among the 3 distinct money groups (i.e., 0, 150, and 500 kr). The analyses displayed a significant difference in successful outcomes between groups that bet 0 ($N = 2$) and 150 kr ($N = 15$) ($x^2(1) = 9.941, p < .01$), groups that invested 0 ($N = 2$) and 500 kr ($N = 14$) ($x^2(1) = 9, p < .01$), but no significant difference in success rates of groups that invested 150 and 500 kr ($x^2(1) = .034, p = .853$) (see Fig. 3a). **These results indicate that users who invested money in a workout challenge using Goalkeeper were significantly more probable to complete it, as opposed to those who did not invest any money** (RQ1). Similarly, a Pearson chi-square test of independence was performed to investigate if there is an association between the duration of the challenge and its outcome. However, the test displayed no significant association between the duration of a challenge and its outcome ($x^2(1) = .765, p = .382, V = -.126$) (see Fig. 3b). **This indicates that the duration of the challenge did not play a significant role in completing a challenge** (RQ1).

A series of tests next aimed at investigating perceived motivation in relation to committing to a challenge, and investing a deposit in a challenge. A Pearson chi-square test of independence displayed a significant association between self-reported motivation due to using Goalkeeper ("*I think that participating in a Goalkeeper challenge improves my motivation to exercise.*") and reported exercise hours per week ($x^2(18) = 38.368, p < .01, V = .516$). Inter-

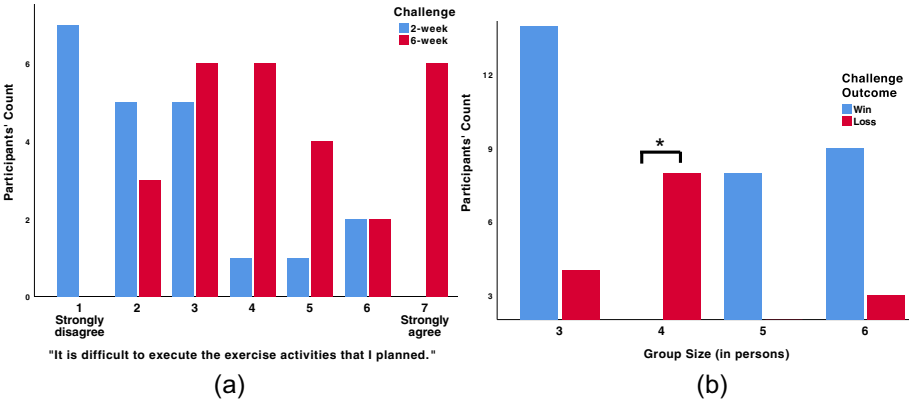

Fig. 4. (a) There was a significant association between self-reported exercise difficulty and challenge duration. (b) Group size played a significant role in challenge outcome for 4-person groups simply because all 4-person groups invested no money as deposits.

estingly, self-reported challenge difficulty ("*It is difficult to execute the exercise activities that I planned.*") was not associated with challenge outcome ($x^2(6) = 2.283, p = .892, V = .218$), but it was significantly associated with challenge duration ($x^2(6) = 18.501, p < .01, V = .621$) (see Fig. 4a). Nevertheless, **having a deposit contract was reported as a significant factor for convincing one to complete a challenge**. Indeed, a Pearson chi-square test of independence revealed a significant association between self-reported determination ("*I felt the money gave me motivation not to fail.*") and challenge outcome ($x^2(6) = 12.770, p < .05, V = .516$). Post-hoc pairwise comparison tests using the Bonferroni correction revealed no significant differences among the different Likert-scores. Next, we also inquired into whether the challenge outcome played a significant role in participants' self-reported motivation to continue exercise after a challenge was completed. However, a Pearson chi-square test of independence displayed no significant association between self-reported future motivation to exercise ("*I am motivated to continue exercise after the challenge.*") and challenge outcome ($x^2(6) = 4.640, p = .461, V = .311$). These findings highlight that **deposit contracts are an effective strategy for motivating physical activity via a mobile application such as Goalkeeper** (RQ1).

5.2 Group Dynamics and Peer Competition (RQ2)

In this subsection, we investigate whether group characteristics played an important role in pursuing a physical exercise challenge with Goalkeeper. At first, a Pearson-chi square test of independence demonstrated a significant association between group size and challenge outcome ($x^2(3) = 17.567, p < .01, V = .605$). Interestingly, post-hoc pairwise tests using the Bonferroni correction revealed a significant difference in the challenge outcome for 4-person groups (0 wins,

8 losses, $p < .001$) (see Fig. 4b). When we had a closer look into why the two 4-person groups had no wins, we found out that both groups were all-female groups that invested 0 kr as a deposit. Having classified our groups into 3 main categories based on participants' genders that comprised them (i.e., all-male, all-female, and mixed), we investigated if group gender had an effect on challenge outcome. However, a Pearson-chi square test of independence displayed no significant association between group gender and challenge outcome ($x^2(2) = 5.749, p = .056, V = .346$). Interestingly, a Pearson-chi square test of independence revealed a significant difference for group gender in the amount of deposit invested ($x^2(4) = 13.452, p < .01, V = .374$). Post-hoc pairwise tests using the Bonferroni correction revealed a significant difference in the number of participants belonging to all-female groups ($N = 8$) and the number of participants belonging to mixed groups ($N = 0$) that invested 0 kr as a deposit ($p < .001$). This indicates that **groups that included participants of both genders were more likely to use deposit contracts investing actual money, as opposed to female-only groups** (RQ2).

Next, we investigated a series of self-reported measures on how group collaboration influenced challenge outcome. In particular, a Pearson chi-square test of independence displayed no significant association between self-reported degree of peer cooperation in exercise ("*My friends exercised with me.*" | $Mdn = 2$) and outcome challenge ($x^2(6) = 4.833, p = .565, V = .317$). Similarly, there was no significant association between self-reported degree of reminding to exercise by peers ("*My friends gave me helpful reminders to exercise.*" | $Mdn = 5$) ($x^2(6) = 9.699, p = .138, V = .450$), self-reported peer encouragement ("*My friends gave me encouragement to stick with my exercise program.*" | $Mdn = 3$) ($x^2(6) = 7.328, p = .292, V = .391$), and self-reported peer-schedule flexibility ("*My friends changed their schedule so we could exercise together.*" | $Mdn = 3$) ($x^2(6) = 6.063, p = .416, V = .355$) with challenge outcome. However, we were able to unveil a significant association between self-reported willingness to enlist more peers ("*I want more friends to join the challenge to increase the pot.*" | $Mdn = 4$) for maximizing returns ($x^2(6) = 12.624, p < .05, V = .513$). These findings showcase that **participants that belonged to the same group did not collaborate in the course of an exercise challenge** (RQ2).

5.3 User Profile Effects (RQ3)

Here, we investigated if certain aspects of our participants' profiles (e.g., age, gender, habits, personality traits, and feelings) bear an effect on deposit amount, challenge duration, and challenge outcome. A Mann-Whitney U test displayed a significant difference in the median amount deposited by each gender ($U = -2.754, p < .01$). In particular, **male participants invested in a challenge significantly greater amounts ($M = 291.67, SE = 41.120$) than females did** ($M = 139.58, SE = 36.487$). However, **gender did not play a substantial role in completing a challenge**. In particular, a Pearson-chi square test of independence displayed no significant association between gender and challenge outcome ($x^2(1) = 2.277, p = .131, V = .218$). Interestingly, age appears to bear

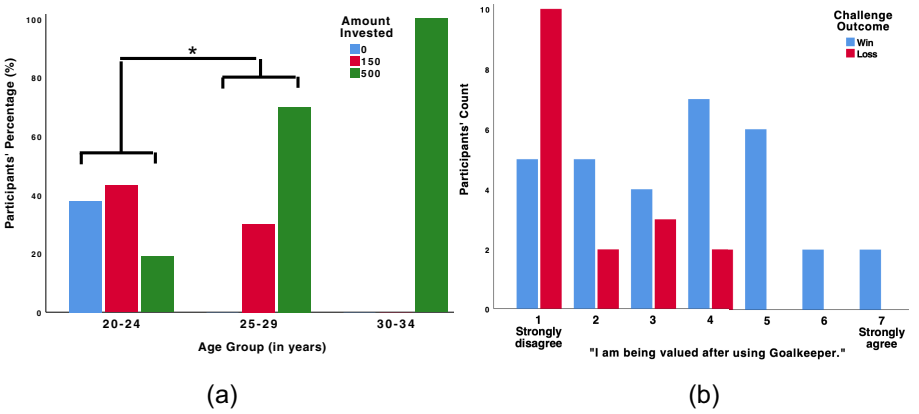

Fig. 5. (a) We unveiled a significant difference between the deposit amounts invested in an exercise challenge by 20–24 and 25–29 age groups. (b) There was a significant association between self-reported self-value and challenge outcome.

an effect on deposit amounts invested by different age groups. A Kruskal-Wallis H test revealed a significant difference in the amounts deposited by each age group ($x^2(2) = 11.742, p < .05$) for the age groups of 20–24 ($Mdn = 150$), 25–29 ($Mdn = 500$), and 30–34 ($Mdn = 500$) (see Fig. 5a). After excluding the 30–34 age group for low occurrence ($N = 1$), a follow-up Mann-Whitney U test displayed a significant difference in the median invested amounts between 20–24 ($Mdn = 150$) and 25–29 ($Mdn = 500$) age groups ($U = 69.500, p < .01$). However, age appears to have no bearing on successfully completing an exercise challenge ($x^2(2) = .771, p = .680, V = .127$). In sum, **gender and age displayed a significant impact on deposit amount, but not on challenge outcome** (RQ3).

For investigating if prior exercising habits and schedules influenced challenge outcome, we performed a Pearson chi-square test of independence. The analysis displayed no significant association between prior exercising and challenge outcome ($x^2(1) = .440, p = .507, V = .096$). This indicates that people who exercise regularly did not have an advantage over those who did not in winning a challenge. Similarly, self-reported competitiveness ("*I think I am competitive.*") exhibited no significant association with challenge outcome ($x^2(5) = 2.392, p = .793, V = .223$). Also, prior self-reported betting experience ("*I have previously joined a bet with money.*") did not display any significant association with the amount of the deposit invested in an exercise challenge via the Goalkeeper ($x^2(2) = .027, p = .987, V = .096$). These findings indicate that **prior exercising habits and betting experience did not affect substantially challenge outcome and deposit amount** (RQ3).

However, self-reported positive feelings displayed strong associations with challenge outcome. For example, a Pearson chi-square test of independence unveiled a significant association between self-reported "warm feeling" ("*I have*

a warm feeling after using Goalkeeper.") and challenge outcome ($x^2(6) = 12.624, p < .05, V = .096$). Similarly, self-reported self-value ("*I am being valued after using Goalkeeper.*") was also found significantly associated with challenge outcome ($x^2(6) = 12.886, p < .05, V = .518$) (see Fig. 5b). Interestingly, investigating self-reported negative feelings revealed no significant associations to challenge outcomes. In particular, two Pearson chi-square tests of independence revealed no significant associations between self-reported bad mood ("*I am in a bad mood after using Goalkeeper.*") ($x^2(4) = 5.852, p = .211, V = .349$), and self-reported anger levels ("*I feel angry after using Goalkeeper.*") ($x^2(5) = 3.788, p = .580, V = .281$). These findings suggest that **Goalkeeper was more frequently associated with positive than negative feelings** (RQ3).

6 Discussion

Beyond the immense benefits of physical activity for the human body, adopting an active lifestyle could help save billions of euros in health care costs in the years to come. According to a report from the World Health Organization (WHO) in the EU Region, for a European country of 10 million people, of whom half are insufficiently active, the overall incurred health cost is estimated to be 910€ million per year [48]. Nowadays, health insurance companies are increasingly introducing policies that encourage people to stay active (e.g., TK-App). We believe exergames that involve financial incentives to increase physical activity can inherently contribute more in the health and well-being economy, when compared to typical gamification approaches (e.g., points, achievements). This paper highlights the potential of deposit contracts and peer competition in increasing physical exercise motivation. By drawing on our findings, we elicit design principles for exergames that involve financial incentives.

6.1 Embrace Risk and Design for the Long-Run

Overall, deposit contracts as monetary incentives proved to significantly increase physical activity for our participants. In fact, the median reported exercise duration before using Goalkeeper was between 1 to 4 h per week. While pursuing an exercise challenge with Goalkeeper, participants reported a median of 5 to 9 exercise duration per week. Interestingly, when having a look at challenge outcome, in relation to the amount of the deposit invested in a challenge, we observe a significantly higher success rate for participants who invested 150 kr as opposed to those who invested 0 kr. This indicates that participants who invested money in an exercise challenge using Goalkeeper were significantly more dedicated to completing it, compared to those who did not invest any money at all (RQ1). These findings are directly inline with prior findings in literature, where monetary incentives were found to support weight-loss [36] and motivate physical activity [1,4,12,51]. Interestingly, one would expect that a challenge of a longer duration would display substantially lower completion rates than a challenge of a shorter duration (RQ1). Contrary to our expectations, the success rate of

the 2-week challenge did not differ significantly from the success rate of the 6-week challenge, despite the fact that the 6-week challenge lasted 3 times longer. However, challenge duration was not associated with challenge outcome. **This possibly demonstrates that deposit contracts is an effective way to keep people committed to exercise challenges over long periods**. This finding should be noted as it indicates that deposit contracts, and Goalkeeper, bear substantial potential to promote the formation of healthy habits. In fact, 21 days is believed to be the threshold for forming a new habit, with others raising the threshold to 66 days [32]. Although, we did a followup interview with our participants 2 weeks after a challenge had concluded, we will need to investigate exercise habits over longer periods to reliably claim that Goalkeeper forms strong exercising habits. However, we found a significant association between self-reported motivation and exercise duration per week. Moreover, we detected a significant association between reported determination to complete a challenge and challenge outcome. This suggests that by further manipulating the deposit amount and the challenge duration, Goalkeeper could be instrumental in forming exercising habits. **Thus, loss aversion theory may serve as a driver of positive behavioral change when sufficiently long periods are involved**.

6.2 Design for Peer Competition in Zero-Sum Exergame Settings

Recent studies in literature report only moderate effects for deposit contracts in increasing one's motivation to exercise when one's own assets are not involved [12,36]. Even so, the very nature of loss aversion theory is counter-intuitive in our approach in the first place. **From the outset, loss aversion per se should discourage one from unnecessarily jeopardizing one's own assets for no clear financial benefit** [63]. Enabling loss aversion was the reason for a rather low monetary incentive (75 kr) to participate in the study. In fact, the incentive amount pales in comparison to the amounts invested from participants' own money (150 and 500 kr). Thus, we have a reason to believe that deposit contracts did not single-handedly improve our participants' motivation to exercise. In other words, we believe that our participants did not simply exercise just to take their money back. Instead, we think that **peer pressure generated by peer competition played a substantial role, not only in completing a challenge, but also in mitigating barriers to entry (i.e., investing money)**.

On one hand, we discovered that participants who belonged to groups which did not invest any money in an exercise challenge were significantly less probable to complete it, as opposed to groups which did (see RQ1). On the other hand, when having a look at measures that characterize self-reported collaboration in a group (e.g., exercise together), we detected no association with challenge outcome. In fact, participants reported relatively low cooperation, if any, during the course of an exercise challenge (RQ2). We believe this can be explained by our participants treating a Goalkeeper challenge as a zero-sum game—in a way it actually is. However, **zero-sum games should involve gain or loss of utility to effectively motivate physical exercise**.

6.3 Design for the Group and the Individual

Interestingly, when having a look at participants' profiles and characteristics, we were able to unveil additional effects. For example, we found that gender played a significant role in deposit amount, with male participants investing on average 292 kr as opposed to 140 for females (RQ3). We ascribe this finding to males typically displaying a risk-taking behavior more frequently than females do [14]. Age also had a significant impact on deposit amount, with the age group of 20–24 years depositing 150 kr for an exercise challenge, as opposed to the age group of 25–29 years that deposited 500 kr (RQ3). This finding is also aligned with prior evidence in literature, where income appears positively correlated with age [13]. However, neither gender nor age displayed a significant effect on challenge outcome. Moreover, one would assume that someone who exercises regularly bears an advantage over someone who does not, when it comes to completing an exercise challenge. However, we did not find any effect of prior exercising habits on deposit amount or challenge outcome. A plausible explanation for this is that we set a rather low difficulty threshold (i.e., 3 exercise sessions per week of at least 30 min each) for one's physique to play a substantial role in deposit amount or challenge outcome. All in all, **exergames that utilize own financial incentives in group settings should implement group decision policies on the intensity, type, and duration of the exercise challenge, as well as the amount invested**.

Interestingly, prior experience with betting or lottery games was neither associated with deposit amount nor challenge outcome. This possibly indicates that **participants did not perceive Goalkeeper as a betting game**. Finally, we were surprised to discover that Goalkeeper was only linked to inducing positive feelings, as reported by our participants. On one hand, challenge outcome was associated with participants reporting exhibiting a "warm feeling," and feeling valued. On the other hand, we did not find any association between challenge outcome and the emotion of anger, or bad mood. A plausible explanation is that our participants perceived Goalkeeper as part of their exercise routine (RQ3). Exercising is generally associated with positive emotions [7], and reduced stress [54]. **Positive emotions related to physical exercise may reinforce the adoption of an exergame, leading to the formation of an exercise habit** [5].

6.4 Limitations

As young adults, we assume our participants were innately keen on technology and novel applications. Being also students, we expect that our participants had ample time to pursue an exercise challenge with the Goalkeeper app. Thus, physical challenge completion rates for older age groups may have been lower. However, Goalkeeper supports setting challenges that even people who do not originally exercise can complete. In fact, for this study we already set a lower exercise threshold than the recommended 150 min of moderate exercise per week. For simplicity, we employed pre-made challenges that did not distinguish between

different types of physical activity (e.g., cycling, running, etc.) or different levels of exercise intensity (e.g., walking vs. running). Nevertheless, Goalkeeper, via the Strava API, can detect and identify different exercise types and intensity levels, and thus support highly customized challenges. Our participants organized themselves in groups freely based on friendship, and thus we do not expect significant socioeconomic disparities within groups [11]. We acknowledge that our findings generalize in the context of a northern European country, and sample populations from different cultural and socioeconomic backgrounds might affect our results. Even so, Goalkeeper enables peers to set physical exercise challenges with deposit contracts of any amount and in any currency. Moreover, we did not account for the event a participant failed to complete a challenge due to illness. Currently, a feature is developed that enables one to report illness on Goalkeeper and reclaim one's deposit. Finally, although we have evidence that Goalkeeper may facilitate the habit formation of exercising regularly, we will still need to investigate this over substantially longer periods than that of 6 weeks.

7 Conclusion and Future Work

Lack of physical activity is not only considered the prime culprit for a range of preventable causes of death across the globe, but it has also been associated with substantial health costs for the state. As a result, increasing and sustaining exercise motivation has been in the spotlight for a range of related research fields, including HCI. However, numerous existing solutions adopt highly sophisticated approaches that often involve the use of expensive hardware and bulky equipment, restricted by default to indoor settings, or reporting clinically modest results. In this work, we introduced Goalkeeper, a mobile application that fosters exercise motivation by the interplay between deposit contracts and peer competition. Our results showcase that participants who invested money in a physical exercise challenge using Goalkeeper were significantly more dedicated to completing it, while challenge duration appeared of secondary importance. Thus, peer competition and loss aversion provide a "carrot-and-stick" approach to effectively increasing physical exercise motivation. In future work, we will investigate exercise motivation for Goalkeeper over substantially longer periods. All in all, we believe exergames that employ one's own financial incentives in group settings bear a significant potential to advance the formation of strong physical exercise habits that in turn promote a healthier lifestyle.

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